THE AGB NEWSLETTER

An electronic publication dedicated to Asymptotic Giant Branch stars and related phenomena

Official publication of the IAU Working Group on Abundances in Red Giants

No. 201 — 1 April 2014

http://www.astro.keele.ac.uk/AGBnews

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 201st issue of the AGB Newsletter. Planetary nebulæ, chemical abundances and stellar winds are popular topics, but there's lots more.

Please bring the Ph.D. adverts from Uppsala, Bordeaux and Leuven to the attention of your best undergraduate or masters students; and consider attending the workshop in Bonn.

The next issue is planned to be distributed around the 1st of May.

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Super-AGB stars explode

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

On the necessity of composition-dependent low-temperature opacity in models of metal-poor AGB stars

Thomas Constantino[1], *Simon Campbell*[1], *Pilar Gil-Pons*[2] *and John Lattanzio*[1]

[1]Monash Centre for Astrophysics (MoCA), School of Mathematical Sciences, Monash University, Victoria, 3800, Australia
[2]Department of Applied Physics, Polytechnic University of Catalonia, 08860 Barcelona, Spain

The vital importance of composition-dependent low-temperature opacity in low-mass ($M \leq 3$ M$_\odot$) asymptotic giant branch (AGB) stellar models of metallicity $Z \geq 0.001$ has recently been demonstrated (e.g., Marigo 2002; Ventura & Marigo 2010). Its significance to more metal-poor, intermediate mass ($M \geq 2.5$ M$_\odot$) models has yet to be investigated. We show that its inclusion in lower-metallicity models ([Fe/H] ≤ -2) is essential and that there exists no threshold metallicity below which composition-dependent molecular opacity may be neglected. We find it to be crucial in all intermediate-mass models investigated ([Fe/H] ≤ -2 and $2.5 \leq M/\mathrm{M}_\odot \leq 5$), because of the evolution of the surface chemistry, including the orders of magnitude increase in the abundance of molecule-forming species. Its effect on these models mirrors that previously reported for higher-metallicity models – increase in radius, decrease in T_{eff}, faster mass loss, shorter thermally pulsing AGB lifetime, reduced enrichment in third dredge-up products (by a factor of 3–10), and an increase in the mass limit for hot bottom burning. We show that the evolution of low-metallicity models with composition-dependent low-temperature opacity is relatively independent of initial metal abundance because its contribution to the opacity is far outweighed by changes resulting from dredge-up. Our results imply a significant reduction in the expected number of nitrogen-enhanced metal-poor stars, which may help explain their observed paucity. We note that these findings are partially a product of the macrophysics adopted in our models, in particular the Vassiliadis & Wood (1993) mass-loss rate which is strongly dependent on radius.

Accepted for publication in The Astrophysical Journal
Available from arXiv:1401.7752

A search for magnetic fields on central stars in planetary nebulæ

F. Leone[1], *R.L.M. Corradi*[2,3], *M.J. Martínez González*[2,3], *A. Asensio Ramos*[2,3] *and R. Manso Sainz*[2,3]

[1]Università di Catania, Dipartimento di Fisica e Astronomia, Sezione Astrofisica, Via S. Sofia 78, I–95123 Catania, Italy
[2]Instituto de Astrofísica de Canarias, 38205, La Laguna, Tenerife, Spain
[3]Departamento de Astrofisica, Universidad de La Laguna, E-38205 La Laguna, Tenerife, Spain

One of the possible mechanisms responsible for the panoply of shapes in planetary nebulæ is the presence of magnetic fields that drive the ejection of ionized material during the proto-planetary nebula phase. Therefore, detecting magnetic fields in such objects is of key importance for understanding their dynamics. Still, magnetic fields have not been detected using polarimetry in the central stars of planetary nebulæ. Circularly polarized light spectra have been obtained with the Focal Reducer and Low Dispersion Spectrograph at the Very Large Telescope of the European Southern Observatory and the Intermediate dispersion Spectrograph and Imaging System at the *William Herschel* Telescope. Twenty-three planetary nebulæ spanning very different morphology and evolutionary stages have been selected. Most of central stars have been observed at different rotation phases to point out evidence of magnetic variability. In this paper, we present the result of two observational campaigns aimed to detect and measure the magnetic field in the central stars of planetary nebulæ on the basis of low resolution spectropolarimetry. In the limit of the adopted method, we can state that large scale fields of kG order are not hosted on the central star of planetary nebulæ.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1401.6282
and from http://dx.doi.org/10.1051/0004-6361/201322753

Heavy elements in Globular Clusters: the role of AGB stars

Oscar Straniero[1], *Sergio Cristallo*[1] *and Luciano Piersanti*[1]

[1]INAF–Osservatorio di Teramo, Italy

Recent observations of heavy elements in Globular Clusters reveal intriguing deviations from the standard paradigm of the early galactic nucleosynthesis. If the r-process contamination is a common feature of Halo stars, s-process enhancements are found in a few Globular Clusters only. We show that the combined pollution of AGB stars with mass ranging between 3 to 6 $M_\odot$ may account for most of the features of the s-process overabundance in M 4 and M 22. In these stars, the s process is a mixture of two different neutron-capture nucleosynthesis episodes. The first is due to the $^{13}C(\alpha,n)^{16}O$ reaction and takes place during the interpulse periods. The second is due to the $^{22}Ne(\alpha,n)^{25}Mg$ reaction and takes place in the convective zones generated by thermal pulses. The production of the heaviest s elements (from Ba to Pb) requires the first neutron burst, while the second produces large overabundances of light s (Sr, Y, Zr). The first mainly operates in the less-massive AGB stars, while the second dominates in the more-massive. From the heavy-s/light-s ratio, we derive that the pollution phase should last for 150 ± 50 Myr, a period short enough compared to the formation timescale of the Globular Cluster system, but long enough to explain why the s-process pollution is observed in a few cases only. With few exceptions, our theoretical prediction provides a reasonable reproduction of the observed s-process abundances, from Sr to Hf. However, Ce is probably underproduced by our models, while Rb and Pb are overproduced. Possible solutions are discussed.

Accepted for publication in ApJ

Rummaging inside the Eskimo's parka: Variable asymmetric PN fast wind and a binary nucleus?

Raman Prinja[1] *and Miguel Urbaneja*[2]

[1]Dept. of Physics and Astronomy, University College London, London, UK

[2]Institute for Astro- and Particle Physics, University of Innsbruck, Inssbruck, Austria

We report on high-resolution optical time-series spectroscopy of the central star of the 'Eskimo' planetary nebula NGC 2392. Datasets were secured with the ESO 2.3m in 2006 March and CFHT 3.6m in 2010 March to diagnose the fast wind and photospheric properties of the central star. The He I and He II recombination lines reveal evidence for clumping and temporal structures in the fast wind that are erratically variable on timescales down to $\sim$ 30 min (i.e. comparable to the characteristic wind flow time). We highlight changes in the overall morphology of the wind lines that cannot plausibly be explained by line-synthesis model predictions with a spherically homogeneous wind. Additionally we present evidence that the UV line profile morphologies support the notion of a high-speed, high-ionization polar wind in NGC 2392. Analyses of deep-seated, near-photospheric absorption lines reveals evidence for low-amplitude radial velocity shifts. Fourier analysis points tentatively to a $\sim$ 0.12-d modulation in the radial velocities, independently evident in the ESO and CFHT data. We conclude that the overall spectroscopic properties support the notion of a (high inclination) binary nucleus in NGC 2392 and an asymmetric fast wind.

Accepted for publication in MNRAS
Available from arXiv:1403.1480

The *Herschel* Planetary Nebula Survey (HerPlaNS) I. Data overview and analysis demonstration with NGC 6781

T. Ueta[1,2], *D. Ladjal*[1], *K.M. Exter*[3], *M. Otsuka*[4], *R. Szczerba*[5], *N. Siodmiak*[5], *I. Aleman*[6], *P.A. M. van Hoof*[7], *J.H. Kastner*[8], *R. Montez Jr.*[9], *I. McDonald*[10], *M. Wittkowski*[11], *C. Sandin*[12], *S. Ramstedt*[13], *O. De Marco*[14], *E. Villaver*[15], *Y.-H. Chu*[16], *W. Vlemmings*[17], *H. Izumiura*[18], *R. Sahai*[19], *J.A. Lopez*[20], *B. Balick*[21], *A.A. Zijlstra*[10], *A.G.G.M. Tielens*[6], *R.E. Rattray*[1], *E. Behar*[22], *E.G. Blackman*[23], *K. Hebden*[10], *J.L. Hora*[24], *K. Murakawa*[25], *J. Nordhaus*[26], *R. Nordon*[27] *and I. Yamamura*[2]

[1]University of Denver, USA
[2]ISAS/JAXA, Japan
[3]K.U. Leuven, Belgium
[4]ASIAA, Taiwan
[5]NCAC, Poland
[6]Leiden University, The Netherlands
[7]ROB/KSB, Belgium
[8]RIT, USA
[9]Vanderbilt University, USA
[10]Jodrell Bank CfA, UK
[11]ESO, Germany
[12]AIP, Germany
[13]Uppsala University, Sweden
[14]Macquarie University, Australia
[15]UAM, Spain
[16]UIUC, USA
[17]Chalmers University of Technology, Sweden
[18]OAO/NAOJ, Japan
[19]JPL/Caltech, USA
[20]UNAM, México
[21]University of Washington, USA
[22]Technion, Israel
[23]University of Rochester, USA
[24]Harvard–Smithsonian CfA, USA
[25]University of Leeds, UK
[26]CCRG/RIT, USA
[27]MPE, Germany

Context: This is the first of a series of investigations into far-IR characteristics of 11 planetary nebulæ (PNs) under the *Herschel* Space Observatory Open Time 1 program, *Herschel* Planetary Nebula Survey (HerPlaNS).
Aims: Using the HerPlaNS data set, we look into the PN energetics and variations of the physical conditions within the target nebulæ. In the present work, we provide an overview of the survey, data acquisition and processing, and resulting data products.
Methods: We perform (1) PACS/SPIRE broadband imaging to determine the spatial distribution of the cold dust component in the target PNs and (2) PACS/SPIRE spectral energy distribution (SED) and line spectroscopy to determine the spatial distribution of the gas component in the target PNs.
Results: For the case of NGC 6781, the broadband maps confirm the nearly pole-on barrel structure of the amorphous carbon-rich dust shell and the surrounding halo having temperatures of 26–40 K. The PACS/SPIRE multi-position spectra show spatial variations of far-IR lines that reflect the physical stratification of the nebula. We demonstrate that spatially-resolved far-IR line diagnostics yield the (T_e, n_e) profiles, from which distributions of ionized, atomic, and molecular gases can be determined. Direct comparison of the dust and gas column mass maps constrained by the HerPlaNS data allows to construct an empirical gas-to-dust mass ratio map, which shows a range of ratios with the median of 195 ± 110. The present analysis yields estimates of the total mass of the shell to be 0.86 $M_\odot$, consisting of 0.54 $M_\odot$ of ionized gas, 0.12 $M_\odot$ of atomic gas, 0.2 $M_\odot$ of molecular gas, and 4×10^{-3} $M_\odot$ of dust grains. These estimates also suggest that the central star of about 1.5 $M_\odot$ initial mass is terminating its PN evolution onto the white dwarf cooling track.
Conclusions: The HerPlaNS data provide various diagnostics for both the dust and gas components in a spatially-

resolved manner. In the forthcoming papers of the HerPlaNS series we will explore the HerPlaNS data set fully for the entire sample of 11 PNs.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:1403.2494

The multi-scale environment of RS Cnc from CO and H I observations

D.T. Hoai[1,2], *L.D. Matthews*[3], *J.M. Winters*[4], *P.T. Nhung*[1,2], *E. Gérard*[5], *Y. Libert*[1,4] *and T. Le Bertre*[1]

[1]LERMA, UMR 8112, CNRS & Observatoire de Paris, 61 av. de l'Observatoire, F-75014 Paris, France

[2]VATLY/INST, 179 Hoang Quoc Viet, Cau Giay, Ha Noi, Vietnam

[3]MIT Haystack Observatory, Off Route 40, Westford, MA 01886, USA

[4]IRAM, 300 rue de la Piscine, Domaine Universitaire, F-38406 St. Martin d'Hères, France

[5]GEPI, UMR 8111, CNRS & Observatoire de Paris, 5 Place J. Janssen, F-92195 Meudon Cedex, France

We present a detailed study of the circumstellar gas distribution and kinematics of the semi-regular variable star RS Cnc on spatial scales ranging from $\sim 1''$ (~ 150 au) to $\sim 6'$ (~ 0.25 pc). Our study utilizes new CO 1–0 data from the Plateau-de-Bure Interferometer and new H I 21-cm line observations from the *Jansky* Very Large Array (JVLA), in combination with previous observations. New modeling of CO 1–0 and CO 2–1 imaging observations leads to a revised characterization of RS Cnc's previously identified axisymmetric molecular outflow. Rather than a simple disk-outflow picture, we find that a gradient in velocity as a function of latitude is needed to fit the spatially resolved spectra, and in our preferred model, the density and the velocity vary smoothly from the equatorial plane to the polar axis. In terms of density, the source appears quasi-spherical, whereas in terms of velocity the source is axi-symmetric with a low expansion velocity in the equatorial plane and faster outflows in the polar directions. The flux of matter is also larger in the polar directions than in the equatorial plane. An implication of our model is that the stellar wind is still accelerated at radii larger than a few hundred au, well beyond the radius where the terminal velocity is thought to be reached in an asymptotic giant branch star. The JVLA H I data show the previously detected head-tail morphology, but also supply additional detail about the atomic gas distribution and kinematics. We confirm that the 'head' seen in H I is elongated in a direction consistent with the polar axis of the molecular outflow, suggesting that we are tracing an extension of the molecular outflow well beyond the molecular dissociation radius (up to ~ 0.05 pc). The $6'$-long H I 'tail' is oriented at a PA of 305°, consistent with the space motion of the star. The tail is resolved into several clumps that may result from hydrodynamic effects linked to the interaction with the local interstellar medium. We measure a total mass of atomic hydrogen $M_{\rm HI} \approx 0.0055$ M$_\odot$ and estimate a lower limit to the timescale for the formation of the tail to be $\sim 6.4 \times 10^4$ years.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1403.2163

Binary central stars of planetary nebulæ with long orbits: the radial velocity orbit of BD+33.2642 (PN G 052.7+50.7) and the orbital motion of HD 112313 (PN Lo Tr5)

Hans Van Winckel[1], *Alain Jorissen*[2], *Katrina Exter*[1], *Gert Raskin*[1], *Saskia Prins*[1], *Jesus Perez Padilla*[1], *Florian Merges*[1] *and Wim Pessemier*[1]

[1]Instituut voor Sterrenkunde, K.U. Leuven, Belgium

[2]Institut d'Astronomie et d'Astrophysique, ULB, Brussels, Belgium

We study the impact of binary interaction processes on the evolution of low- and intermediate-mass stars using long-term monitoring of their radial velocity.
Here we report on our results on the central stars of two planetary nebulæ (PNe): the well-studied spectrophotometric

standard BD +33.2642 (central star of PN G 052.7+50.7) and HD 112313 (central star of PN L Tr5), the optical light of which is dominated by a rapidly rotating G star.
The high-resolution spectra were cross-correlated with carefully selected masks of spectral lines. The individual masks were optimised for the spectral signatures of the dominant contributor of the optical light.
We report on the first detection of orbital motion in these two objects. For BD +33.2642 we sampled 1.5 cycles of the 1105 ± 24 day orbital period. For HD 112313 a full period is not yet covered, despite our 1807 days of monitoring. The radial-velocity amplitude shows that it is unlikely that the orbital plane is co-planar with the one defined by the nebular waist of the bipolar nebula. To our knowledge these are the first detections of orbits in PNe that are in a range from several weeks to a few years.
The orbital properties and chemical composition of BD +33.2642 are similar to what is found in post-AGB binaries with circumbinary discs. The latter are probably progenitors of these PNe. For Lo Tr5 the Ba-rich central star and the long orbital period are similar to the Ba star giants, which hence serve as natural progeny. In contrast to the central star in Lo Tr5, normal Ba stars are slow rotators. The orbits of these systems have a low probability of occurrence according to recent population synthesis calculations.

Accepted for publication in Astronomy and Astrophysics Letters
Available from arXiv:1403.2605

The wind of W Hydræ as seen by *Herschel*. I. The CO envelope

T. Khouri[1], A. de Koter[1,2], L. Decin[1,2], L.B.F.M. Waters[1,3], R. Lombaert[2], P. Royer[2], B. Swinyard[4,5], M.J. Barlow[5], J. Alcolea[6], J.A.D.L. Blommaert[2,7], V. Bujarrabal[8], J. Cernicharo[9], M.A.T. Groenewegen[10], K. Justtanont[11], F. Kerschbaum[12], M. Mærcker[13], A. Marston[14], M. Matsuura[5], G. Melnick[15], K.M. Menten[16], H. Olofsson[11,17], P. Planesas[6], E. Polehampton[4,18], Th. Posch[12], M. Schmidt[19], R. Szczerba[19], B. Vandenbussche[2] and J. Yates[5]

[1]Astronomical Institute Anton Pannekoek, University of Amsterdam, P.O. Box 94249, 1090 GE Amsterdam, The Netherlands
[2]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D 2401, 3001 Leuven, Belgium
[3]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[4]RAL Space, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, UK
[5]Dept. of Physics & Astronomy, University College London, Gower St., London WC1E 6BT, UK
[6]Observatorio Astronómico Nacional (IGN), Alfonso XII No 3, 28014 Madrid, Spain
[7]Department of Physics and Astrophysics, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
[8]Observatorio Astronómico Nacional (OAN–IGN), Apartado 112, 28803 Alcalá de Henares, Spain
[9]Centro de Astrobiología (CSIC/INTA), Ctra. de Torrejón a Ajalvir, km 4, 28850 Torrejón de Ardoz, Madrid, Spain
[10]Koninklijke Sterrenwacht van België, Ringlaan 3, 1180 Brussels, Belgium
[11]Onsala Space Observatory, Dept. of Earth and Space Sciences, Chalmers University of Technology, 43992 Onsala, Sweden
[12]University of Vienna, Department of Astrophysics, Türkenschanzstraße 17, 1180 Wien, Austria
[13]European Southern Observatory, Karl Schwarzschild Str. 2, 85748 Garching bei München, Germany
[14]European Space Astronomy Centre, Urb. Villafranca del Castillo, P.O. Box 50727, 28080 Madrid, Spain
[15]Harvard–Smithsonian Center for Astrophysics, Cambridge MA 02138, USA
[16]Max-Planck-Institut für Radioastronomie, auf dem Hügel 69, 53121 Bonn, Germany
[17]Department of Astronomy, AlbaNova University Center, Stockholm University, 10691 Stockholm, Sweden
[18]Institute for Space Imaging Science, University of Lethbridge, 4401 University Drive, Lethbridge, Alberta T1J 1B1, Canada
[19]N. Copernicus Astronomical Center, Rabianska 8, 87-100 Torún, Poland

Asymptotic giant branch (AGB) stars lose their envelopes by means of a stellar wind whose driving mechanism is not understood well. Characterizing the composition and thermal and dynamical structure of the outflow provides constraints that are essential for understanding AGB evolution, including the rate of mass loss and isotopic ratios.
We modeled the CO emission from the wind of the low mass-loss rate oxygen-rich AGB star W Hya using data obtained by the HIFI, PACS, and SPIRE instruments onboard the *Herschel* Space Observatory and ground-based telescopes. ^{12}CO and ^{13}CO lines are used to constrain the intrinsic ^{12}C/^{13}C ratio from resolved HIFI lines.
The acceleration of the outflow up to about 5.5 km s^{-1} is quite slow and can be represented by a β-type velocity law with index $\beta = 5$. Beyond this point, acceleration up the terminal velocity of 7 km s^{-1} is faster. Using the $J = 10$–9,

9–8, and 6–5 transitions, we find an intrinsic $^{12}C/^{13}C$ ratio of 18 ± 10 for W Hya, where the error bar is mostly due to uncertainties in the ^{12}CO abundance and the stellar flux around 4.6 μm. To match the low-excitation CO lines, these molecules need to be photo-dissociated at about 500 stellar radii. The radial dust emission intensity profile measured by PACS images at 70 μm shows substantially stronger emission than our model predicts beyond 20 arcsec.
The initial slow acceleration of the wind implies inefficient wind driving in the lower part of the envelope. The final injection of momentum in the wind might be the result of an increase in the opacity thanks to the late condensation of dust species. The derived intrinsic isotopologue ratio for W Hya is consistent with values set by the first dredge-up and suggestive of an initial mass of 2 $M_\odot$ or more. However, the uncertainty in the main-sequence mass derived based on this isotopologic ratio is large.

Published in Astronomy & Astrophysics

Circumstellar effects on the Rb abundances in O-rich AGB stars

O. Zamora [1,2], *García-Hernández*[1,2], *B. Plez*[3] *and A. Manchado*[1,2,4]

[1]Instituto de Astrofísica de Canarias (IAC), E-38200 La Laguna, Tenerife, Spain

[2]Departamento de Astrofísica, Universidad de La Laguna (ULL), E-38206 La Laguna, Tenerife, Spain

[3]Laboratoire Univers et Particules de Montpellier, Université Montpellier 2, CNRS, F-34095 Montpellier, France

[4]Consejo Superior de Investigaciones Científicas (CSIC), Spain

For the first time we explore the circumstellar effects on the Rb (and Zr) abundance determination in O-rich asymptotic giant branch (AGB) stars by considering the presence of a gaseous circumstellar envelope with a radial wind. A modified version of the spectral synthesis code Turbospectrum was used to deal with extended atmosphere models and velocity fields. The Rb and Zr abundances were determined from the resonant 7800 Å Rb I line and the 6474 Å ZrO bandhead, respectively, in five representative O-rich AGB stars with different expansion velocities and metallicities. By using our new dynamical models, the Rb I line profile (photospheric and circumstellar components) is very well reproduced. Interestingly, the derived Rb abundances are much lower (by 1–2 dex) in those O-rich AGB stars showing the higher circumstellar expansion velocities. The Zr abundances, however, remain close to the solar values. The Rb abundances and [Rb/Zr] ratios derived here significantly resolve the problem of the present mismatch between the observations of intermediate-mass (4–8 $M_\odot$) Rb-rich AGB stars and the AGB nucleosynthesis theoretical predictions.

Accepted for publication in A&A Letters
Available from arXiv:1403.2075
and from http://www.iac.es/preprints/files/PP14021.pdf

The chemical evolution of fluorine in the Bulge – high-resolution K-band spectra of giants in three fields

H. Jönsson[1], *N. Ryde*[1], *G.M. Harper*[2], *K. Cunha*[3], *M. Schultheis*[4], *K. Eriksson*[5], *C. Kobayashi*[6], *V.V. Smith*[7] *and M. Zoccali*[8]

[1]Lund Observatory, Department of Astronomy and Theoretical Physics, Lund University, Box 43, SE-221 00 Lund, Sweden

[2]School of Physics, Trinity College, Dublin 2, Ireland

[3]Observatório Nacional, Rua General José Cristino, 77, 20921-400 São Cristóvão, Rio de Janeiro, RJ, Brazil

[4]Observatoire de la Côte d'Azur, Boulevard de l'Observatoire, B.P. 4229, F 06304 NICE Cedex 4, France

[5]Department of Physics and Astronomy, Uppsala University, Box 516, SE-751 20 Uppsala, Sweden

[6]Centre for Astrophysics Research, University of Hertfordshire, Hatfield AL10 9AB, United Kingdom

[7]National Optical Astronomy Observatory, 950 North Cherry Avenue, Tucson, AZ 85719, USA

[8]Instituto de Astrofísica, Pontifica Universidad Católica de Chile, Casilla 306, Santiago 22, Chile

Context: Possible main formation sites of fluorine in the Universe include AGB stars, the ν-process in Type II

supernovæ, and/or Wolf–Rayet stars. The importance of the Wolf–Rayet stars has theoretically been questioned and they are probably not needed in the modelling of the chemical evolution of fluorine in the solar neighborhood. It has, however, been suggested that Wolf–Rayet stars are indeed needed to explain the chemical evolution of fluorine in the Bulge. The molecular spectral data, needed to determine the fluorine abundance, of the often used HF-molecule has not been presented in a complete and consistent way and has recently been debated in the literature.
Aims: We intend to determine the trend of the fluorine–oxygen abundance ratio as a function of a metallicity indicator in the Bulge to investigate the possible contribution from Wolf–Rayet stars. Additionally, we present here a consistent HF line list for the K- and L-bands including the often used 23358.33 Å line.
Methods: High-resolution near-infrared spectra of eight K giants were recorded using the spectrograph CRIRES mounted at the VLT. A standard setting was used covering the HF molecular line at 23358.33 Å. The fluorine abundances were determined using spectral fitting. We have also re-analyzed five previously published Bulge giants observed with the Phoenix spectrograph on Gemini using our new HF molecular data.
Results: We find that the fluorine–oxygen abundance in the Bulge probably cannot be explained with chemical evolution models including only AGB-stars and the ν-process in supernovæ Type II, i.e. a significant amount of fluorine production in Wolf–Rayet stars is likely needed to explain the fluorine abundance in the Bulge. Concerning the HF line list, we find that a possible reason for the inconsistencies in the literature, with two different excitation energies being used, is two different definitions of the zero-point energy for the HF molecule and therefore also two accompanying different dissociation energies. Both line lists are correct, as long as the corresponding consistent partition function is used in the spectral synthesis. However, we suspect this has not been the case in several earlier works leading to fluorine abundances approximately 0.3 dex too high. We present a line list for the K- and L-bands and an accompanying partition function.

Accepted for publication in A&A
Available from arXiv:1403.2594

ExoMol line lists IV: The rotation–vibration spectrum of methane up to 1500 K

S.N. Yurchenko[1] *and J. Tennyson*[1]

[1]Department of Physics and Astronomy, University College London, London WC1E 6BT, UK

A new hot line list is calculated for $^{12}CH_4$ in its ground electronic state. This line list, called 10to10, contains 9.8 billion transitions and should be complete for temperatures up to 1500 K. It covers the wavelengths longer than 1 μm and includes all transitions to upper states with energies below $hc \cdot 18\,000$ cm^{-1} and rotational excitation up to $J = 39$. The line list is computed using the eigenvalues and eigenfunctions of CH_4 obtained by variational solution of the Schrödinger equation for the rotation–vibration motion of nuclei employing program TROVE and a new 'spectroscopic' potential energy surface (PES) obtained by refining an ab initio PES (CCSD(T)-F12c/aug-cc-pVQZ) through least-squares fitting to the experimentally derived energies with $J = 0$–4 and a previously reported ab initio dipole moment surface (CCSD(T)-F12c/aug-cc-pVTZ). Detailed comparisons with other available sources of methane transitions including HITRAN, experimental compilations and other theoretical line lists show that these sources lack transitions both higher temperatures and near infrared wavelengths. The 10to10 line list is suitable for modelling atmospheres of cool stars and exoplanets. It is available from the CDS database as well as at www.exomol.com.

Accepted for publication in Mon. Not. R. Astron. Soc.
Available from arXiv:1401.4852

Ionization correction factors for planetary nebulæ. I. Using optical spectra

Gloria Delgado-Inglada[1], *Christophe Morisset*[1] *and Grażyna Stasińska*[2]

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo. Postal 70264, Méx. D.F., 04510, México

[2]LUTH, Observatoire de Paris, CNRS, Université Paris Diderot; Place Jules Janssen 92190 Meudon, France

We compute a large grid of photoionization models that covers a wide range of physical parameters and is representative of most of the observed PNe. Using this grid, we derive new formulæ for the ionization correction factors (ICFs) of He, O, N, Ne, S, Ar, Cl, and C. Analytical expressions to estimate the uncertainties arising from our ICFs are also provided. This should be useful since these uncertainties are usually not considered when estimating the error bars in element abundances. Our ICFs are valid over a variety of assumptions such as the input metallicities, the spectral energy distribution of the ionizing source, the gas distribution, or the presence of dust grains. Besides, the ICFs are adequate both for large aperture observations and for pencilbeam observations in the central zones of the nebulæ. We test our ICFs on a large sample of observed PNe that extends as far as possible in ionization, central star temperature, and metallicity, by checking that the Ne/O, S/O, Ar/O, and Cl/O ratios show no trend with the degree of ionization. Our ICFs lead to significant differences in the derived abundance ratios as compared with previous determinations, especially for N/O, Ne/O, and Ar/O.

Published in Monthly Notices of the Royal Astronomical Society
Available from arXiv:1402.4852

C/O abundance ratios, iron depletions, and infrared dust features in Galactic planetary nebulæ

Gloria Delgado-Inglada[1,2] *and Mónica Rodríguez*[1]

[1]Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE), México

[2]Instituto de Astronomía, UNAM, México

We study the dust present in 56 Galactic planetary nebulæ (PNe) through their iron depletion factors, their C/O abundance ratios (in 51 objects), and the dust features that appear in their infrared spectra (for 33 objects). Our sample objects have deep optical spectra of good quality, and most of them also have ultraviolet observations. We use these observations to derive the iron abundances and the C/O abundance ratios in a homogeneous way for all the objects. We compile detections of infrared dust features from the literature and we analyze the available *Spitzer*/IRS spectra. Most of the PNe have C/O ratios below one and show crystalline silicates in their infrared spectra. The PNe with silicates have $C/O < 1$, with the exception of Cn 1-5. Most of the PNe with dust features related to C-rich environments (SiC or the 30 μm feature usually associated to MgS) have $C/O \gtrsim 0.8$. PAHs are detected over the full range of C/O values, including 6 objects that also show silicates. Iron abundances are low in all the objects, implying that more than 90% of their iron atoms are deposited into dust grains. The range of iron depletions in the sample covers about two orders of magnitude, and we find that the highest depletion factors are found in C-rich objects with SiC or the 30 μm feature in their infrared spectra, whereas some of the O-rich objects with silicates show the lowest depletion factors.

Published in Astrophysical Journal
Available from arXiv:1402.6376

Herschel/PACS observations of the 69-μm band of crystalline olivine around evolved stars

J.A.D.L. Blommaert[1,2,11], *B.L. de Vries*[1,12,13], *L.B.F.M. Waters*[3,4], *C. Waelkens*[1], *M. Min*[4], *H. Van Winckel*[1], *F. Molster*[5], *L. Decin*[1], *M.A.T. Groenewegen*[6], *M. Barlow*[7], *P. García-Lario*[8], *F. Kerschbaum*[9], *Th. Posch*[9], *P. Royer*[1], *T. Ueta*[10], *B. Vandenbussche*[1], *G. Van de Steene*[6] *and P. van Hoof*[6]

[1]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[2]Astronomy and Astrophysics Research Group, Department of Physics and Astrophysics, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

[3]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands

[4]Sterrenkundig Instituut Anton Pannekoek, University of Amsterdam, Science Park 904, 1098 XH, Amsterdam, The Netherlands

[5]Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA, Leiden, The Netherlands

[6]Koninklijke Sterrenwacht van België, Ringlaan 3, 1180 Brussel, Belgium

[7]Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK

[8]Herschel Science Centre, European Space Astronomy Centre, Research and Scientific Support Department of ESA, Villafranca del Castillo, E-28080 Madrid, Spain

[9]University of Vienna, Department of Astrophysics, Türkenschanzstraße 17, 1180 Wien, Asutria

[10]Department of Physics and Astronomy, MS 6900, University of Denver, Denver, CO 80208, USA

[11]Flemish Institute for Technological Research (VITO), Boeretang 200, 2400 Mol, Belgium (present address)

[12]AlbaNova University Centre, Stockholm University, Department of Astronomy, SE-106 91 Stockholm, Sweden

[13]Stockholm University Astrobiology Centre, SE-106 91 Stockholm, Sweden

We present 48 *Herschel*/PACS spectra of evolved stars in the wavelength range of 67–72 μm. This wavelength range covers the 69-μm band of crystalline olivine ($Mg_{2-2x}Fe_{(2x)}SiO_4$). The width and wavelength position of this band are sensitive to the temperature and composition of the crystalline olivine. Our sample covers a wide range of objects: from high mass-loss rate AGB stars (OH/IR stars, $\dot{M} \geq 10^{-5}$ M$_\odot$ yr^{-1}), through post-AGB stars with and without circumbinary disks, to planetary nebulæ and even a few massive evolved stars. The goal of this study is to exploit the spectral properties of the 69-μm band to determine the composition and temperature of the crystalline olivine. Since the objects cover a range of evolutionary phases, we study the physical and chemical properties in this range of physical environments. We fit the 69-μm band and use its width and position to probe the composition and temperature of the crystalline olivine. For 27 sources in the sample, we detected the 69-μm band of crystalline olivine ($Mg_{(2-2x)}Fe_{(2x)}SiO_4$). The 69-$\mu$m band shows that all the sources produce pure forsterite grains containing no iron in their lattice structure. The temperature of the crystalline olivine as indicated by the 69-μm band, shows that on average the temperature of the crystalline olivine is highest in the group of OH/IR stars and the post-AGB stars with confirmed Keplerian disks. The temperature is lower for the other post-AGB stars and lowest for the planetary nebulæ. A couple of the detected 69-μm bands are broader than those of pure magnesium-rich crystalline olivine, which we show can be due to a temperature gradient in the circumstellar environment of these stars. The disk sources in our sample with crystalline olivine are very diverse. They show either no 69-μm band, a moderately strong band, or a very strong band, together with a temperature for the crystalline olivine in their disk that is either very warm ($\sim$ 600 K), moderately warm ($\sim$ 200 K), or cold ($\sim$ 120 K), respectively.

Accepted for publication in A&A
Available from arXiv:1403.6335

s-Processing in AGB stars revisited. I.

O. Trippella[1,2], *M. Busso*[1,2], *E. Maiorca*[3,2], *F. Käppeler*[4] *and S. Palmerini*[5]

[1]Department of Physics and Geology, university of Perugia, Italy

[2]INFN – Section of Perugia, Italy

[3]INAF – Observatory of Arcetri, Italy

[4]Karlsruhe Institut of Technology, Karlsruhe, Germany

[5]INFN – Laboratori Nazionali del Sud, Catania, Italy

Neutrons for s-processing at $A \gtrsim 85$ are mainly provided by ^{13}C(α,n)^{16}O in AGB stars, requiring some proton pen-

etration below the envelope so far assumed to be of small mass ($\lesssim 10^{-3}$ $M_\odot$ yr^{-1}). However, models with rotation suggested that there excessive ^{14}N would hamper *s*-processing. On the other hand, *s*-element abundances in Galaxies require ^{13}C-rich layers more extended in mass. We present new calculations for clarifying the above issues, aiming at understanding if the solar composition can help in fixing the extension of the ^{13}C "pocket". We show: i) that mixing "from bottom to top" (like in magnetic buoyancy or other forced mechanisms) might in principle form a ^{13}C reservoir much larger than assumed so far; ii) that stellar models at a suitable metallicity, using a similarly extended pocket would reproduce the main *s*-component as accurately as before; iii) that with the extended pocket the previously envisaged contributions from an unknown nucleosynthesis process (LEPP) would no longer be required. The new scheme also fulfils the requirements of C-star luminosities. Consisting of a few large neutron exposures, it would imply a large production of nuclei below $A = 90$; in particular, $^{86,\,87}Sr$ would be fully synthesized by AGB stars, while ^{88}Sr, ^{89}Y and ^{94}Zr would be contributed more efficiently by the new model. We suggest some tests, which would probably say a final word on the real extension of the ^{13}C pocket.

Accepted for publication in Astrophysical Journal
Available from arXiv:1403.6256

The ionization structure of multiple shell planetary nebulæ. I. NGC 2438

S. Öttl[1], S. Kimeswenger[2,1] and A.A. Zijlstra[3]

[1]Institute for Astro and Particle Physics, Leopold Franzens Universität Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria
[2]Instituto de Astronomía, Universidad Católica del Norte, Avenida Angamos 0610, Antofagasta, Chile
[3]Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

Context: In recent times an increasing number of extended haloes and multiple shells around planetary nebulæ have been discovered. These faint extensions to the main nebula (called the 'rim') trace the mass-loss history of the star, modified by the subsequent evolution of the nebula. Integrated models predict that some haloes may be recombining, and not in ionization equilibrium. But parameters such as the ionization state and thus the contiguous excitation process are not well known. The haloes are very extended, but faint in surface brightness – 10^3 times below the main nebula. The observational limits lead to the need of an extremely well studied main nebula, to model the processes in the shells and haloes of one object. NGC 2438 is a perfect candidate to explore the physical characteristics of the halo.
Aims: The aim is to derive a complete data set of the main nebula rim. This allows us to derive the physical conditions, such as temperature, density and ionization, and clumping, from photoionization models. These models are used to derive whether the halo is in ionization equilibrium.
Methods: Long-slit spectroscopic data at various positions in the nebula were obtained at the ESO 3.6-m and the SAAO 1.9-m telescopes. These data are supplemented by imaging data from the HST archive and from the ESO 3.6-m telescope, and archival VLA observations. The use of diagnostic diagrams draws limits for physical properties in the models. The photoionization code CLOUDY is used to model the nebular properties, and to derive a more accurate distance and ionized mass.
Results: We derive an accurate extinction $E_{\mathrm{B-V}} = 0.16$ mag, and distance of 1.9 ± 0.2 kpc. This puts the nebula behind the nearby open cluster M 46 and rules out membership. The low-excitation species are found to be dominated by clumps. The emission line ratios show no evidence for shocks. The filling factor increases with radius in the nebula. The electron densities in the rim are ~ 250 cm^{-3}, dropping to $\sim$ 10–30 cm^{-3} in the shell. We find the shell in ionization equilibrium: a significant amount of UV radiation infiltrates the inner nebula. Thus the shell still seems to be ionized. The spatially resolved CLOUDY model supports the hypothesis that photoionization is the dominant process in this nebula, far out into the shell. Previous models predicted that the shell would be recombining, but this is not confirmed by the data. We note that these models used a smaller distance, and therefore different input parameters, than derived by us.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1403.6715

Old puzzle, new insights: a lithium rich giant quietly burning helium in its core

V. Silva Aguirre[1], *G.R. Ruchti*[2], *S. Hekker*[3,4], *S. Cassisi*[5], *J. Christensen-Dalsgaard*[1], *A. Datta*[6], *A. Jendreieck*[7], *J. Jessen-Hansen*[1], *A. Mazumdar*[8], *B. Mosser*[9], *D. Stello*[10], *P.G. Beck*[11] *and J. de Ridder*[11]

[1]Stellar Astrophysics Centre, Department of Physics and Astronomy, Århus University, Ny Munkegade 120, DK-8000 Århus C, Denmark

[2]Lund Observatory, Department of Astronomy and Theoretical Physics, Box 43, SE-221 00 Lund, Sweden

[3]Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077, Göttingen, Germany

[4]Astronomical Institute 'Anton Pannekoek', University of Amsterdam, Science Park 904, 1098 HX Amsterdam, The Netherlands

[5]INAF–Astronomical Observatory of Teramo, Via M. Maggini sn, I-64100 Teramo, Italy

[6]Department of Physics and Meteorology, Indian Institute of Technology, Kharagpur – 721302, India

[7]Max-Planck-Institut für Astrophysics, Karl Schwarzschild Straße 1, 85748, Garching bei Münich, Germany

[8]Homi Bhabha Centre for Science Education, TIFR, V. N. Purav Marg, Mankhurd, Mumbai 400088, India

[9]LESIA – Observatoire de Paris, CNRS, Université Pierre et Marie Curie, Université Denis Diderot, 92195 Meudon Cedex, France

[10]Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia

[11]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium

About 1% of giant stars have been shown to have large surface Li abundances, which is unexpected according to standard stellar evolution models. Several scenarios for lithium production have been proposed, but it is still unclear why these Li-rich giants exist. A missing piece in this puzzle is the knowledge of the exact stage of evolution of these stars. Using low-and-high-resolution spectroscopic observations, we have undertaken a survey of lithium-rich giants in the *Kepler* field. In this letter, we report the finding of the first confirmed Li-rich core-helium-burning giant, as revealed by asteroseismic analysis. The evolutionary timescales constrained by its mass suggest that Li-production most likely took place through non-canonical mixing at the RGB-tip, possibly during the helium flash.

Accepted for publication in The Astrophysical Journal Letters
Available from arXiv:1402.6339

Review Paper

AGB stars and presolar grains

M. Busso[1,2], *O. Trippella*[1,2], *E. Maiorca*[2,3] *and S. Palmerini*[4]

[1]Department of Physics and Geology, university of Perugia, Italy

[2]INFN – Section of Perugia, Italy

[3]INAF – Observatory of Arcetri, Italy

[4]INFN – Laboratori Nazionali del Sud, Catania, Italy

Among presolar materials recovered in meteorites, abundant SiC and Al_2O_3 grains of AGB origins were found. They showed records of C, N, O, ^{26}Al and *s*-element isotopic ratios that proved invaluable in constraining the nucleosynthesis models for AGB stars (Zinner et al. 1987; Gallino et al. 1990). In particular, when these ratios are measured in SiC grains, they clearly reveal their prevalent origin in cool AGB circumstellar envelopes and provide information on both the local physics and the conditions at the nucleosynthesis site (the H- and He-burning layers deep inside the structure). Among the properties ascertained for the main part of the SiC data (the so-called *mainstream* ones), we mention a large range of ^{14}N/^{15}N ratios, extending below the solar value [**?**], and ^{12}C/^{13}C ratios $\gtrsim$30. Other classes of grains, instead, display low carbon isotopic ratios ($\gtrsim$10) and a huge dispersion for N isotopes, with cases of large ^{15}N excess. In the same grains, isotopes currently fed by slow neutron captures reveal the characteristic pattern expected from this process at an efficiency slightly lower than necessary to explain the solar main *s*-process component. Complementary constraints can be found in oxide grains, especially Al_2O_3 crystals. Here, the oxygen isotopes and the content in ^{26}Al are of a special importance for clarifying the partial mixing processes that are known to affect evolved low-mass stars. Successes in modeling the data, as well as problems in explaining some of the mentioned isotopic ratios through current nucleosynthesis models are briefly outlined.

Published in AIP – "7$^{\text{th}}$ School of Experimental Nuclear Astrophysics"
Available from arXiv:1312.6580

PhD student positions in Astrophysics

The Division of Astronomy and Space Physics invites applications for PhD student positions financed by Uppsala University. A successful applicant has the opportunity to choose and define a research project within theoretical or observational astrophysics. Current research projects in the Division of Astronomy and Space Physics can be found at http://www.physics.uu.se/astro/en/page/research.

To be eligible for a PhD student position you should have a basic university degree in physics, astronomy or astrophysics (at the MSc level) and fulfill the entry requirements for the PhD program. The applicant's ability to complete the PhD education will be evaluated. The final appointments will be made after interviews with a few top candidates. Funding of PhD studies is for four years. The successful applicants should take up the positions preferably no later than September 2014.

Applications should include a brief description of research interests and past experience, CV, copies of degree diplomas and grades, two reference letters, and copies of any previous research-related work (see link given below for more information and online application form). The university is striving for a more even gender balance in its staff, and women are especially encouraged to apply for this position.

Reference: UFV-PA 2014/875 Application deadline: May 9, 2014

Contact: Susanne Höfner
(susanne.hoefner@physics.uu.se)

See also http://www.uu.se/en/jobs/?positionId=34952

PhD position in the study of Magnetic field in star formation and evolution

A PhD position is available in the "Star Formation" group at the Laboratoire d'Astrophysique de Bordeaux (LAB, OASU, Bordeaux). This fellowship is funded by the Université de Bordeaux. The starting date of the position is October 1st 2014.

The first part of this thesis is to study the influence of the magnetic field during the stellar evolution using existing observations and new observations which will be proposed to IRAM and ALMA observatories. The PhD student will analyze and interpret the observations in the context of the formation and stellar evolution using existing tools. In addition, he will investigate what are the best molecular tracers to study the magnetic field in these objects with current and future telescopes (e.g., ALMA, IRAM, SKA). What are the possible molecular species and possibly more suited than CN, previously used, to study the magnetic field by Zeeman effect?

In addition, the student, and this is the second part of the thesis, will invest himself in the definition of an innovative instrument for performing at best these spectroscopic and polarimetric studies in the future. Based on this work, our laboratory will develop a usable spectrometer prototype for ground-based observatories but also for space, capable of correlating the four Stokes parameters, with a performance gain of more than one order of magnitude.

The gross (net) yearly salary will be 21 080 (17 150) euros, all benefits included. Applicants should have a Master degree and a reasonable background in astrophysics as well as interest for instrument development.

Applications, to include a CV, letter of motivation, one letter or reference, along with the course titles and grades for the past two years are to be emailed to Dr. Fabrice Herpin (herpin@obs.u-bordeaux1.fr). Informal inquiries might be directed to Fabrice Herpin (+33 5 57 77 61 57, email: herpin@obs.u-bordeaux1.fr).

The deadline for submission of applications is May 15th 2014.

See also http://www.obs.u-bordeaux1.fr/radio/FHerpin/PhD2014.pdf

PhD position in Leuven, Belgium
'Unravelling the dust formation process in oxygen-rich AGB stars'

For decades, scientist have been studying the late evolutionary stages of low and intermediate-mass Asymptotic Giant Branch (AGB) stars. These stages are dominated by a strong mass-loss, which enriches the interstellar medium with new chemical elements synthesized in the dense cores. However, as of today, the mechanism triggering the onset of the stellar wind and mass-loss rate in oxygen-rich AGB stars is not yet understood. While theoretical models are in accordance with the mass-loss rates deduced for carbon-rich stars, there is still a large discrepancy in the case of oxygen-rich AGB stars.

The aim of this PhD project is to find answers on the questions which molecules and dust species participate in the wind formation. We were recently granted ALMA data to study at high spatial resolution the molecules contributing to the dust formation process. Using ALMA, it is possible for the first time to get decisive information on the chemical processes, dynamics, and geometrical structure of the dust forming region. You will reduce and analyse these ALMA data, which are complemented with *Herschel* and ISO satellite data and data from ground-based sub-millimeter instruments. Using these data, we will deduce the gas-phase fraction of the different molecules contributing to the dust formation and hence determine the dust formation efficiency. In addition, you will perform a chemical modeling of the inner envelope structure of oxygen-rich AGB stars with the aim to derive the dominant chemical pathways and unravel the mass-loss mechanism in oxygen-rich AGB stars.

See also https://icts.kuleuven.be/apps/jobsite/vacatures/52911145

Announcement

Nucleosynthesis in Asymptotic Giant Branch Stars

The 568. Wilhelm und Else Heræus-Seminar "Nucleosynthesis in Asymptotic Giant Branch Stars" will be held from July 14th to 18th at the Physikzentrum in Bad Honnef. Registration is now open: note that we expect the demand for places to be high, and we have a strict limit on numbers, so be quick!

The seminar will bring together the best scientists working on Asymptotic Giant Branch (AGB) stars, and their students, for a week to:

- Have the world's best AGB experts communicate the state of the art in AGB astrophysics and educate all attendees, especially young researchers who are the experts of tomorrow.
- Examine the critical issues affecting AGB stellar evolution modelling and nucleosynthesis.
- Work together in extended formal and informal discussion/break-out sessions, including small working groups.
- Plan the key international collaborative projects for the next five to ten years.

Invited speakers include Peter Wood, Falk Herwig, Sara Palmerini, Richard Stancliffe, Martin Asplund, Andy Davis, Maria Lugaro, Ian Roederer, Christian Iliadis and Marco Pignatari.

Accommodation costs are covered by our generous Wilhelm und Else Heræus-Stiftung grant, so all you have to do is get here and bring your brain.

See also http://www.astro.uni-bonn.de/agb_bonn2014/